Palynological and geochemical data in peat sediments alongside an old (Roman or Merovingian) paved road in the Hautes-Fagnes

[Données palynologiques et géochimiques de sédiments provenant de tourbières en bordure d'une ancienne route pavée, romaine à/ou mérovingienne, dans les Hautes-Fagnes]

Maurice STREEL[1]

Virginie RENSON[2]

François de VLEESCHOUWER[3]

Citation: STREEL M., RENSON V. & VLEESCHOUWER F. de (2007).- Palynological and geochemical data in peat sediments alongside an old (Roman or Merovingian) paved road in the Hautes-Fagnes. *In*: STEEMANS P. & JAVAUX E. (eds.), Recent Advances in Palynology.- Carnets de Géologie / Notebooks on Geology, Brest, Memoir 2007/01, Abstract 09 (**CG2007_M01/09**)

Key Words: Palynology; geochemistry; peat; Holocene; Belgium; Roman; Merovingian; road

Mots-Clefs : Palynologie ; géochimie ; tourbe ; Holocène ; Belgique ; Romain ; Mérovingien ; route

Introduction

In 1768, a report to her Majesty Empress Marie-Thérèse of Austria, concerning the Duchies of Limburg and Luxemburg, indicated that an old paved road, then covered by peat and vegetation, linked the regions of Eupen and Sourbrodt (now in area called Hautes-Fagnes, in the province of Liège in eastern Belgium). At that time, only a bad trail wound across the region and the users of this trail were obliged to pay toll to the Liège Principality. The paved road, after restoration, would have allowed direct communication between the duchies (Fig. 1).

The paved road, traditionally known to the local inhabitants as the "Pavé de Charlemagne", was never restored and its detailed layout was forgotten until the early 1930's when the abbot J. BASTIN rediscovered and described (BASTIN, 1934) its remarkable structure between the sites of "Croix Mockel" and "Wez" (Fig. 1).

The road was believed to have a Roman origin until several ^{14}C dates obtained at the "Croix Mockel" site (CORBIAU, 1981) suggested a Merovingian age (between A.D. 460 and A.D. 885). Pollen analyses performed in the Wez site (Fig. 2) by DRICOT (1960), DALEMANS & STREEL (1986) and more recently by STREEL *et alii* (2005) generated contradictory conclusions. DRICOT (1960) concluded that the pollen analysis of the peat below the road suggested an age considered to be too old for, but one ^{14}C date supported a Roman age. DALEMANS & STREEL (1986), introduced a new method of dating by pollen analysis of the peaty layers contaminated by mineral dust alongside the road and proposed a Merovingian age. The latest contribution was obtained from a trench made perpendicular to, but alongside the paved road, in a new site investigated by CORBIAU (2005) near the southern border of the Wez. Two profiles were studied (W A and W B) using geochemical (RENSON *et alii*, 2005) as well as palynological (STREEL *et alii*, 2005) techniques on the samples. Helped by several ^{14}C dates, they came to the conclusion that the road was built between A.D. 210-390 and A.D. 380-540, using calibration method Oxcal 3.8. These two dates were then recalibrated using the calibration method Oxcal 3.10 to give an interval ranging from A.D.130-380 to A.D. 350-540. It was then decided to use the same techniques on a new core (W VI) taken at the site investigated by DALEMANS & STREEL (1986).

[1] Laboratoire de Paléobotanique, Paléopalynologie et Micropaléontologie, Université de Liège, Allée du 6 août, B18, Sart-Tilman, 4000 Liège (Belgium)
maurice.streel@ulg.ac.be
[2] URAP, Department of Geology, DGLG-WE-Vrije Universiteit Brussel, Pleinlaan 2, B-1050 Brussels (Belgium)
vrenson@vub.ac.be
[3] Unité de Recherche Argiles et Paléoclimats, University of Liège, Allée du 6 Août B18, Sart Tilman, B-4000 Liège 1 (Belgium)
fdevleeschouwer@student.ulg.ac.be
Manuscript online since March 22, 2007

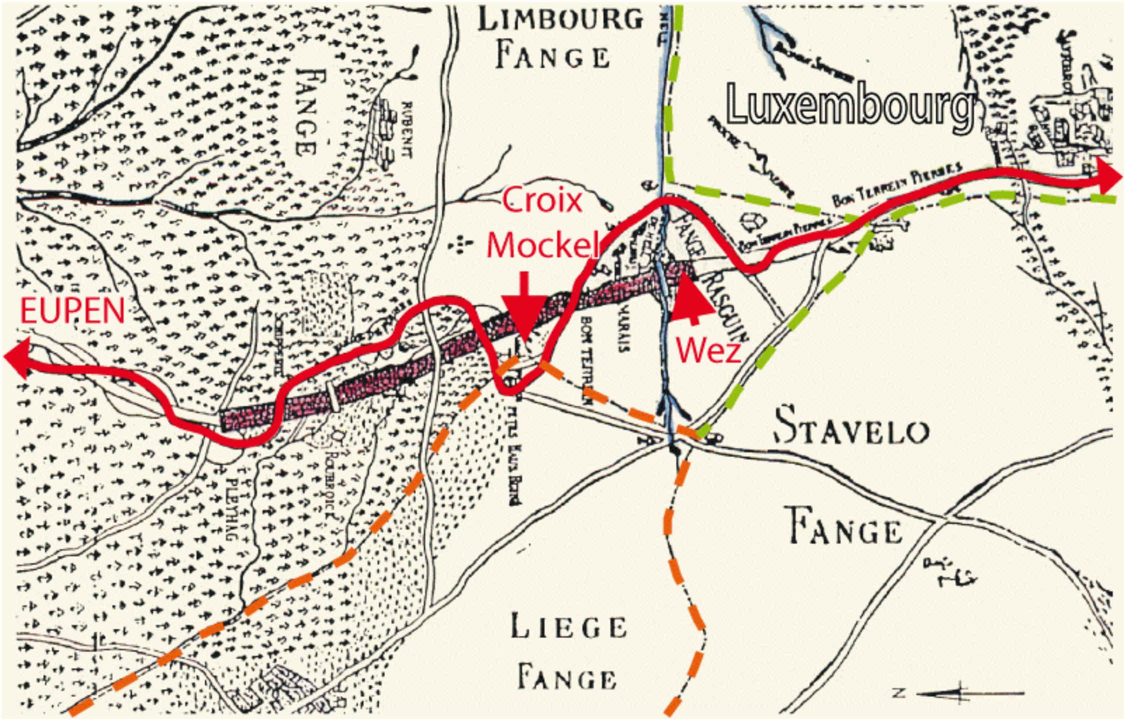

Figure 1: Map drawn by Cornelius LEURS in 1778 (after FAUCHAMPS, 1950). Dotted lines: boundaries between the four Duchies and Principalities which were meeting in the Hautes-Fagnes. The toll fees were to be paid at the site named here "Croix Mockel".

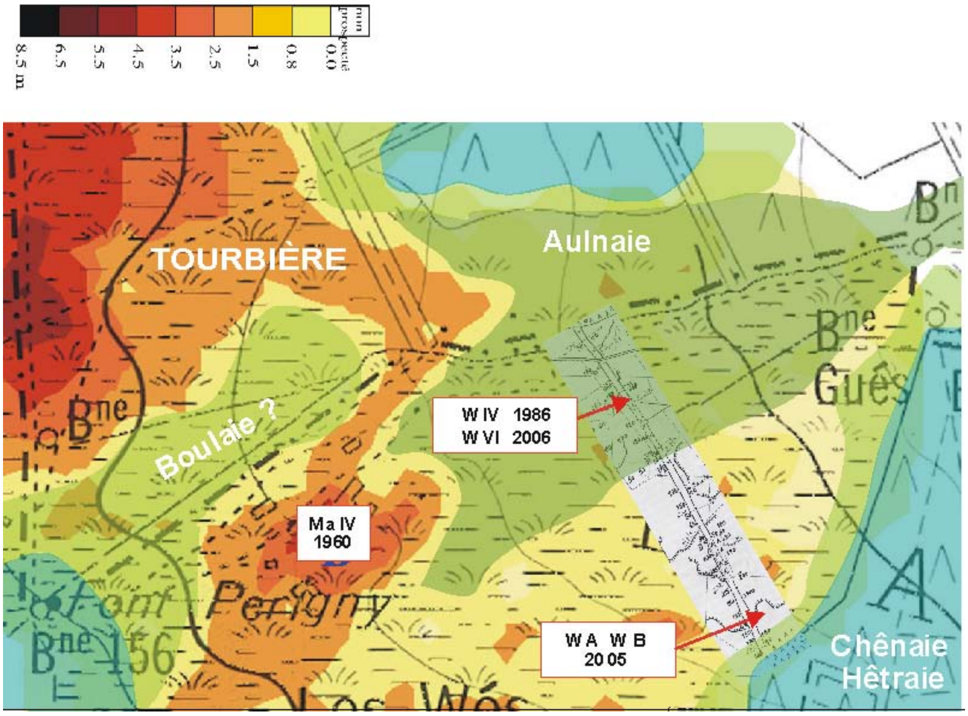

Figure 2: The site "Les Wés" or "Wez" on the right side of the small brook "Helle". Grey shaded area: layout of the paved road (BOLLINNE & STREEL, 1998). Other colours: hypothetical vegetation cover before the road building, based on the soil characteristics and on pollen data. "Aulnaie", "Boulaie", "Chênaie", and "Hêtraie" are woods dominated respectively by *Alnus*, *Betula*, *Quercus* and *Fagus*. Investigated sites are reported (see text for details).

Impact of environment on the pollen rain

It is important to note the environmental differences between the site of profiles W A and W B and the site of cores W IV and VI when the road was built. *Alnus* (alder) makes up to 50% of the total pollen sum in the lower part of W IV and W VI (Figs. 4 - 5) but is smaller in amount and range of variation in profiles W A and W B.

However for dating purposes, the regional pollen rain is of the greatest importance as shown by DRICOT (1960) in his profile Ma IV. Taken in a non-wooded raised bog, regional pollen rain is assumed to be at a maximum. DRICOT (1960) identified 3 of the 4 maxima of *Fagus* (beech) pollen (Fig. 3) recorded by PERSCH (1950) in another peat-bog some 10 km to the north. However, the dates given by PERSCH (1950) were interpolated without ^{14}C control, assuming a constant accumulation rate of the peat and and therefore are of low reliability. Therefore, the correlation made by DRICOT (1960) and the dates given (Fig. 3) are also of low reliability. The presence/absence or frequency of *Carpinus* (hornbeam) is the only criterion for discriminating between FI, FII and FIII. DRICOT (1960) calculated all the percentages on the sum of arboreal pollen (AP).

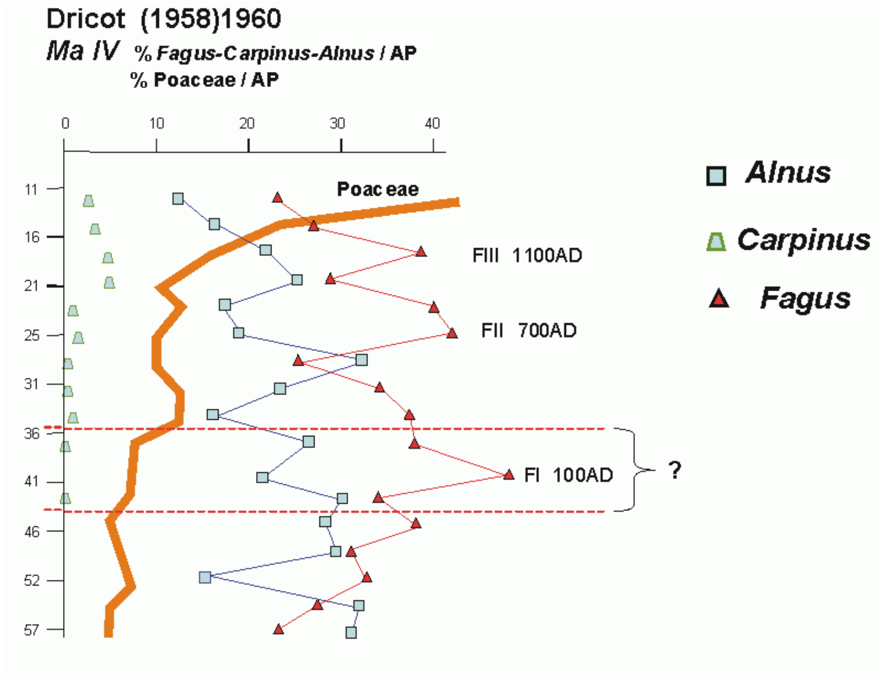

Figure 3: Simplified 5 cm interval pollen diagram Ma IV (DRICOT, 1960) with percentages calculated on arboreal pollen sum (AP). Dates of maxima of *Fagus* pollens based on the pollen analysis of another peat bog, 10 km to the north (PERSCH, 1950). The "?" indicates a possible equivalent of core W VI as explained in text.

The new core W VI (Fig. 4) compared to the old core W IV (Fig. 5)

Core W IV was sampled at 2.5 cm intervals and macerated for pollen analysis, for recording of ash weight/dry peat weight and for isolation of the first occurrence of small (1mm or less) fragments of quartzite in the calcined peat. The new core W VI was sampled every cm and treated like W IV. The same samples were analyzed by geochemistry for later comparison with the data observed in profile W B.

In core W IV, the sudden decline in the percentage of *Alnus* pollen was explained by DALEMANS & STREEL (1986) as the result of the opening of the paved road through the wooded peat-bog associated with the Helle brook. The sudden decline is indeed accompanied in the core by an increase of ash content and by the first occurrence in the calcined peat of small (1 mm or less) fragments of quartzite. It was also considered that the paved road was built there for the first time. In core W VI the decline in the percentage of *Alnus* pollen is again taken to indicate the construction of the new road. However, the decline is more gradual than in W IV because of the closer sampling.

The abundance of *Alnus* pollens in this site along the Helle had to be taken into account when calculating the percentages of pollen from other tree species provided by forests dominating the landscape outside the peat-bogs. Not only is the *Alnus* pollen rain locally more abundant than the regional pollen rain from the surrounding forests, but also the local density of *Alnus* trees may have acted as a shelter from the regional pollen rain. We have therefore recalculated in both cores the percentages of *Fagus* and *Carpinus* in the arboreal pollen sum less *Alnus* in order to reduce the importance of non-arboreal and local pollen rain. This was not done by DALEMANS & STREEL (1986) who had come to the conclusion that the *Fagus* maximum above the decline of *Alnus,* as it was less important than the maximum visible below the decline of *Alnus*, corresponded to the FII of DRICOT (1960). The recalculation of DALEMANS & STREEL's (1986) diagram however shows (Fig. 5) that this *Fagus* maximum could also correspond to the FI.

The *Fagus* maximum in the new core W VI, immediately above the *Alnus* decline might therefore correspond to the FI of DRICOT (1960), here called zone A (Fig. 4). If so, the opening of the road through the *Alnus* wooded peat-bog might be Roman, not Merovingian.

However the drastic increase of ash content (> 50 %) in dry peat is clearly above that of the *Fagus* maxima in both cores. Above the *Fagus* maximum in the new core W VI, identified now as zone B (Fig. 4), a continuous occurrence of Filicales spores implies a superficial more mineralized peat. At the same level occur very abundant cenospheres. They are known to be ash particles resulting from incomplete high-temperature combustion of peat (MILLER & JANSONIUS 1996; GRIFFIN & GOLDBERG, 1979).

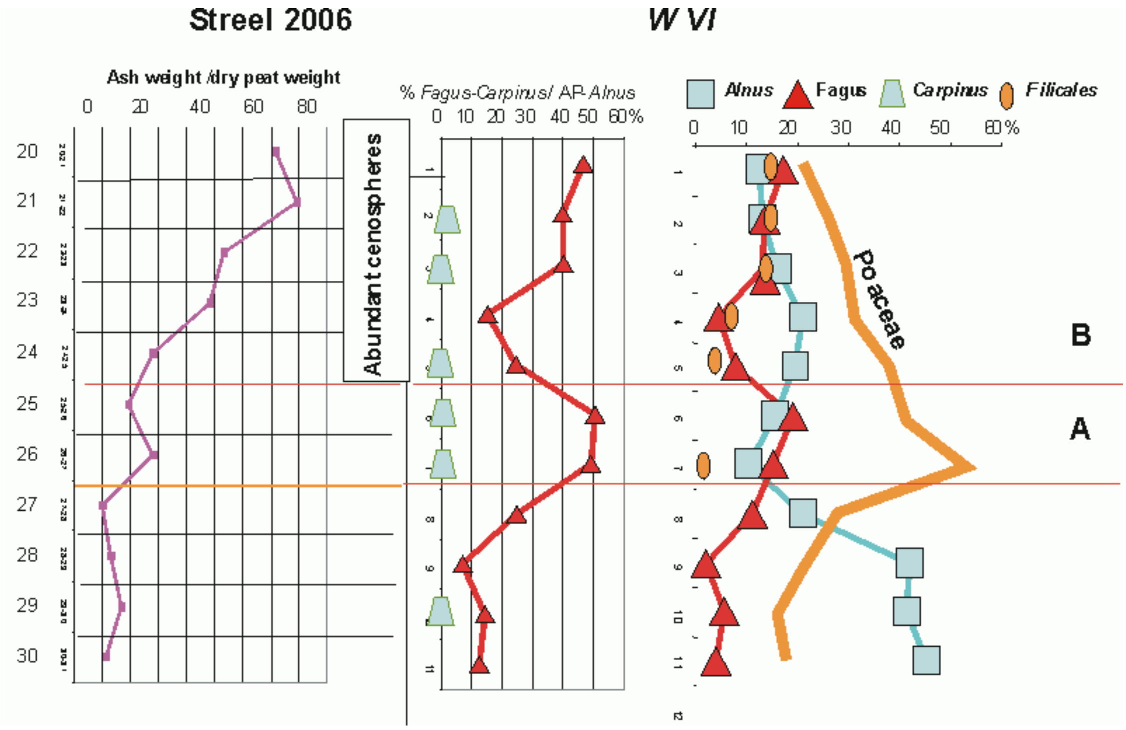

Figure 4: On the right: simplified pollen diagram of core W VI (percentage calculated on total pollen sum). On the left: percentages of ash in dry peat, and levels with abundant cenospheres. In the middle: percentages of *Fagus* and *Carpinus* recalculated on arboreal pollen sum less *Alnus* in order to reduce the importance of non-arboreal and local pollen rain.

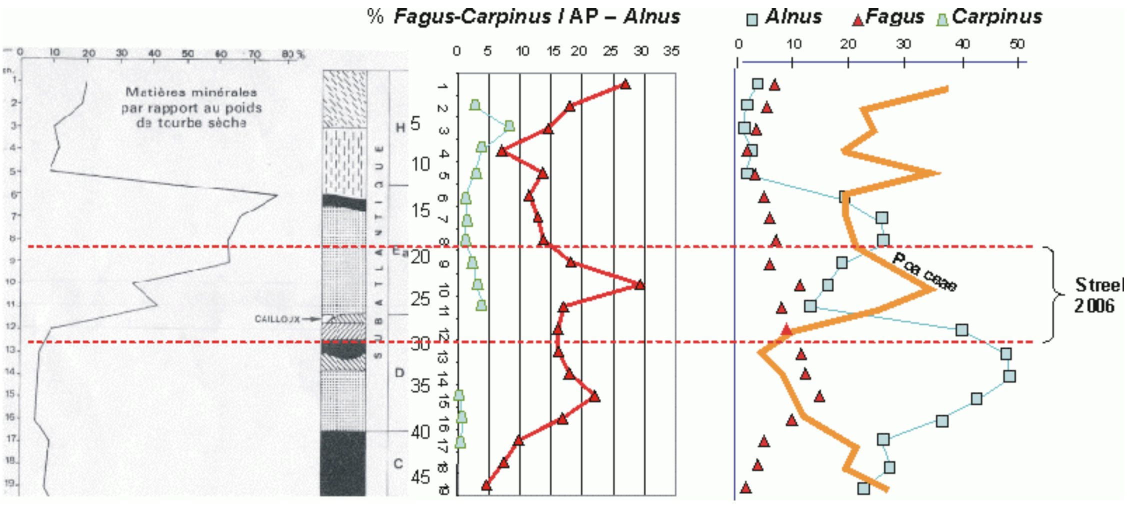

Figure 5: On the right: simplified pollen diagram of core W IV (after DALEMANS & STREEL, 1986) (percentage calculated on total pollen sum). On the left: percentages of ash in dry peat. In the middle: percentages of *Fagus* and *Carpinus* recalculated on arboreal pollen sum less *Alnus* in order to reduce the importance of non-arboreal and local pollen rain.

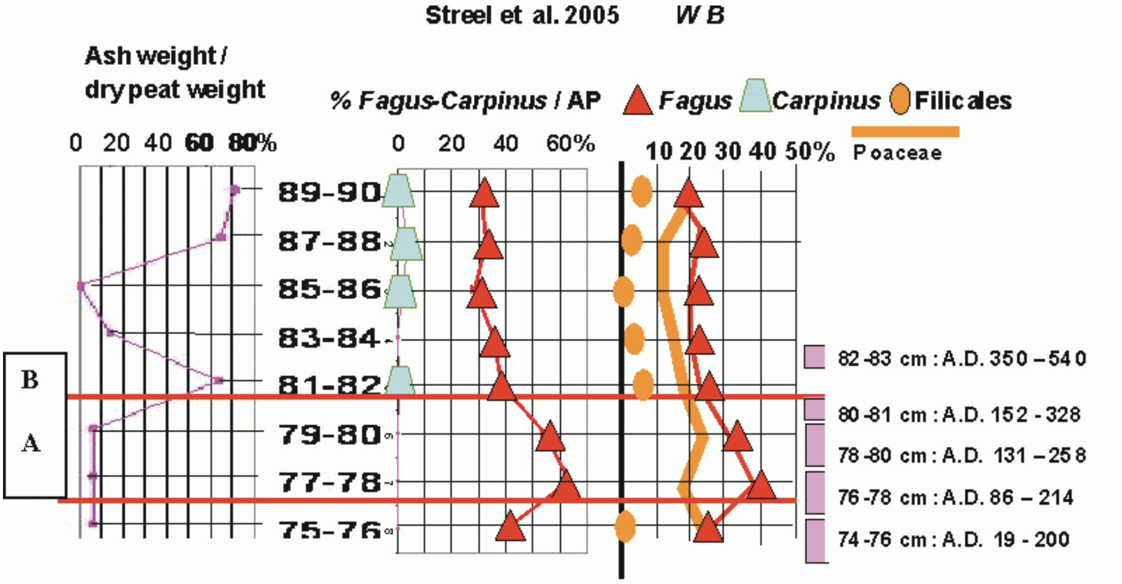

Figure 6: On the right: simplified pollen diagram of profile W B (STREEL *et alii*, 2005) (percentage calculated on total pollen sum). On the left: percentage of ash in dry peat and calibrated ^{14}C intervals. In the middle: percentages of *Fagus* and *Carpinus* recalculated on arboreal pollen sum in order to reduce the importance of non-arboreal pollen rain. Note that the samples in profile W B are measured from the base of the peat layer.

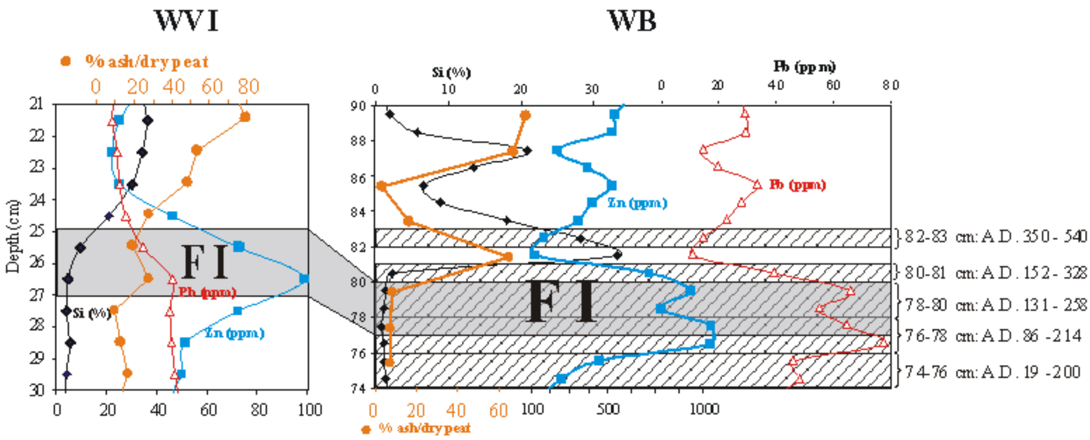

Figure 7: Comparison of geochemical data in new core W VI and profile W B (RENSON *et alii*, 2005) in the case the maximum of *Fagus* FI is confirmed in W VI.

The new core W VI (Figs. 4 & 7) compared to the profile W B (Figs. 6 - 7)

In Figure 6 (a simplified diagram of profile WB), the pollen percentages of *Fagus* and *Carpinus* were recalculated on the arboreal pollen sum only, to reduce the local importance of non arboreal pollen rain in the pollen diagram. This profile W B has been dated by five successive ^{14}C dates. The four lower dates, being very close, allowed recalibration using the wiggle-match dating program Bcal (Figs. 6 - 7). The maxima of *Fagus* were attributed to the FI based on their calibrated ^{14}C age interval of A.D. 86 – A.D. 258. The site W B was not situated in an *Alnus* wooded peat-bog and therefore the supposed man-made *Alnus* decline could not be detected. The ash content in dry peat increases suddenly between 79-80cm and 81-82cm *i.e.* within the time limit of A.D. 131 and A.D. 540.

The drastic increase of silica content between 81 and 82 cm (between A.D. 152 and A.D. 540) in the W B profile attests the presence of quartzite fragments linked to the building of the paved road and the beginning of its use (Fig. 7). This characteristic is also present in W VI although the Si increase in W VI is more progressive than in W B. Moreover, the appearance of Filicales is abrupt in W B while progressive in W VI. These discrepancies between W B and W VI profiles suggest either a difference in the accumulation rate of peat, or a difference in the recording of quartzite fragments. Indeed, the deposition of quartzite fragments on a peat surface is completely chaotic. It is thus possible not only to have a difference in quantity but also in size (small then large in W VI, while all are large in W B) of quartzite fragments, resulting in a difference in Si profiles. However, to clarify this point ^{14}C dating needs be performed in W VI.

Trace element geochemistry shows significant increases in lead and zinc beginning at 70 cm in W B and at 29 cm in W VI. Lead isotopes analyses were performed on some samples presenting high concentrations of lead and zinc (between 70 cm and 94 cm in W B). These samples show isotopic ratios similar to isotopic ratio of lead-zinc ores located approximately 15-20 km to the north-northwest, in the Verviers synclinorium. Therefore, it is possible to suggest the hypothesis that the road could have been used to carry lead-zinc ores from the Verviers-Aachen area through the Hautes-Fagnes region, and then perhaps south-southwest to Trier, an important metal working centre at these times.

Acknowledgements

We wish to express our gratitude to F. DAMBLON (Brussels), B. OWENS (Nottingham) and N. SANDER (Modesto) for improving the paper. This work was supported by a F.N.R.S. grant (geochemistry and datings) and a.s.b.l. "Parc Naturel Hautes Fagnes-Eifel" (datings). Nathalie FAGEL (ULg) is also acknowledged for her comments and support. François de VLEESCHOUWER has a F.R.I.A. fellowship.

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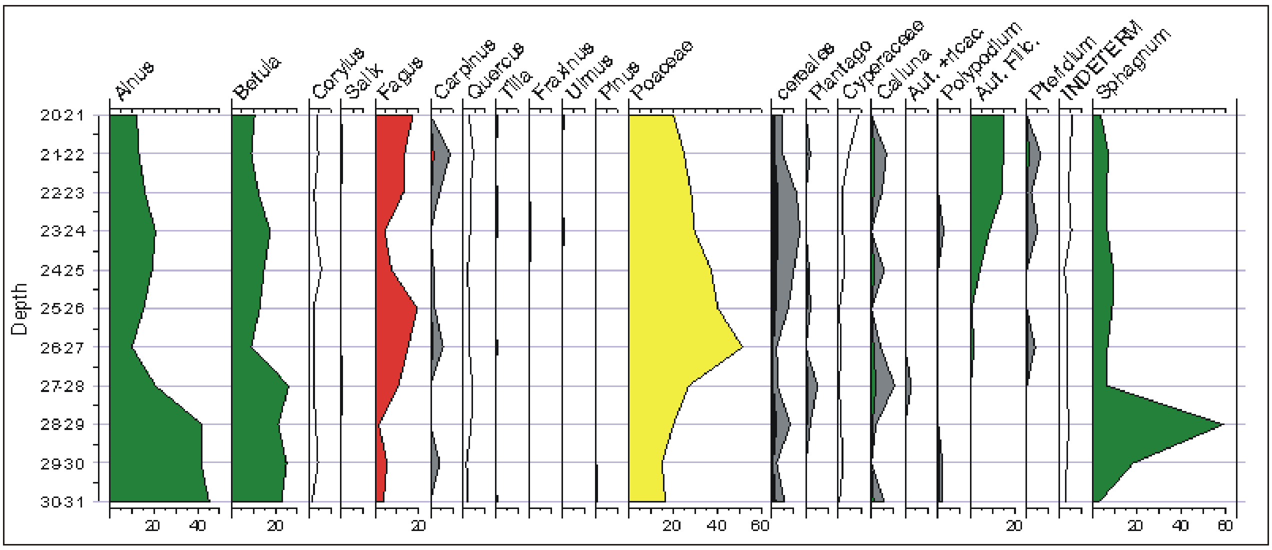

Addendum: Pollen diagram of core W VI. Percentages of all pollens and spores (except *Sphagnum*) on the total sum. Curves of pollens from *Carpinus*, *Cerealia*, *Plantago*, *Calluna*, other Ericaceae and spores of *Polypodium* and *Pteridium* are 5x exaggerated.